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FOREST INSECT AND DISEASE HANDBOOK

RENEWABLE RESOURCES EVALUATION

U.S. Department of Agriculture
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FOREST INSECT AND DISEASE HANDBOOK

Renewable Resources Evaluation

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Preface

This handbook was developed for use by the Renewable Resources Evaluation crews. It is presented in a style and format intended to best meet their needs. The damage classes used and coding system will change for each state survey. A looseleaf notebook format is used to aid users in adding both new pages or revisions of earlier pages, from time to time.

SENDING SPECIMENS FOR IDENTIFICATION

Frequently, specimens arrive in too poor a condition for a good diagnosis. The three major reasons for this are (1) the specimens are too wet, (2) the specimens are too dry, or (3) the specimens have been collected from a portion of the tree showing symptoms, but which do not themselves bear direct evidence of the cause.

Keep free water out of the container and above all, mail the specimen promptly.

Fresh specimens that are mailed promptly will contain adequate moisture if a moist (not dripping) paper towel is enclosed in the mailing container.

Refrigerate specimens that cannot be mailed immediately. Submit specimens that include both dead and healthy tissue. One good example is the oak wilt fungus. It cannot survive at high temperatures, and for this reason should be kept cool from the time the core or chip is removed from the tree. Put the sample in a styrofoam cooler containing ice. In addition, the fungus can be isolated only from moist, recently invaded tissue—not from dry, brittle wood that has since been colonized by secondary organisms.

The third problem is encountered when samples are collected solely on the basis of localized symptoms. For example, dead or

wilted leaves do not necessarily indicate the presence of a foliage disease, but may instead result from the effects of a stem or root disease. Check the host for loose or dead bark, for lesions or cankers on limbs and stems and for root and root collar damage. However, do not submit bark by itself unless cankers or fruiting bodies are present. When possible, try to include woody tissue with the bark. Make a special effort to detect, collect, and submit any fungus fruiting bodies observed and determined to be associated with the disease problem.

The particular environmental conditions surrounding the affected tree can also facilitate the diagnosis. Take note of such things as silting, damage from lawn, road or construction machinery, problems of drought or drainage, evidence of the use of road deicers, poor pruning practices, use of chemicals, closeness to underground pipes or lines, buildings, driveways, curbs, sidewalks, insect activity, etc. Also, include the age and size of the host, when symptoms first appeared and progression of symptoms since they were first observed. A checklist for collecting, diagnosing, and submitting disease or insect specimens in the field is shown in figure 1.

DETECTION REPORT Forest Insect and Disease Damage (Reference FSM 3420)					
PART A INSTRUCTIONS <i>This report is authorized by PL 95-313. Voluntary responses to the report greatly assist the Forest Service in the detection and prevention of potentially destructive insects and diseases. PRINT. Shaded areas to be completed by receiving Agency. Further instructions on inside cover.</i>					
1. TYPE OF LANDOWNERSHIP (X Appropriate Box) <input type="checkbox"/> Federal <input type="checkbox"/> State <input type="checkbox"/> Private		2. UNIT (Indicate specific National Forest, National Park etc.) <div style="border: 1px solid black; width: 100%; height: 20px;"></div>			
3. SUBUNIT (Indicate District or other appropriate subunit) <div style="border: 1px solid black; width: 100%; height: 20px;"></div>					
4. LOCATION OF PROPERTY (If known give drainage name, prominent landmark, mileage from known location.)					
State <div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div> County <div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>					
Township <div style="border: 1px solid black; width: 60px; height: 20px; display: inline-block;"></div>		Range <div style="border: 1px solid black; width: 60px; height: 20px; display: inline-block;"></div>		Section <div style="border: 1px solid black; width: 60px; height: 20px; display: inline-block;"></div>	
1/4 Section <div style="border: 1px solid black; width: 60px; height: 20px; display: inline-block;"></div>					
5. NAME AND BUSINESS ADDRESS (Include Zip Code)				6. PHONE NUMBER (Include Area Code.)	
7. DATE				8. ACTION REQUESTED (X Appropriate Box) <input type="checkbox"/> None <input type="checkbox"/> Identification <input type="checkbox"/> Field Evaluation	
9. SAMPLE ENCLOSED <input type="checkbox"/> YES <input type="checkbox"/> NO		10. MAP ENCLOSED <input type="checkbox"/> YES <input type="checkbox"/> NO		11. ACRES DAMAGED	
12. TREES DAMAGED		13. DISTRIBUTION OF DAMAGE <input type="checkbox"/> Scattered <input type="checkbox"/> Grouped			
14. SPECIES AFFECTED (Indicate species in descending order of damage severity.)					
15. TREE SIZE (X Appropriate Box) <input type="checkbox"/> - 20 Seedling <input type="checkbox"/> - 21 Sapling <input type="checkbox"/> - 22 Pole <input type="checkbox"/> - 23 Sawtimber <input type="checkbox"/> - 24 Overmature					
16. PARTS(S) OF TREES DAMAGED (X Appropriate Box) <input type="checkbox"/> - 30 Root <input type="checkbox"/> - 31 Bole <input type="checkbox"/> - 32 Branch <input type="checkbox"/> - 33 Twig <input type="checkbox"/> - 34 Leader <input type="checkbox"/> - 35 New Foliage <input type="checkbox"/> - 36 Old Foliage <input type="checkbox"/> - 37 Bud <input type="checkbox"/> - 38 Cone/Seed <input type="checkbox"/> - 39 Wood					
17. STAND TYPE (X Appro. Box) <input type="checkbox"/> - 40 Nursery <input type="checkbox"/> - 41 Plantation <input type="checkbox"/> - 42 Natural <input type="checkbox"/> - 43 Shelterbelt <input type="checkbox"/> - 44 Ornamental <input type="checkbox"/> - 45 Seed Orchards					
18. CASUAL AGENTS OR ASSOCIATED DISTURBANCE (X Appropriate Box)					
Insects Disease Mechanical Other					
<div style="display: flex; flex-wrap: wrap;"><div style="width: 25%;"><input type="checkbox"/> - 50 Bark Beetle <input type="checkbox"/> - 51 Defoliator <input type="checkbox"/> - 52 Sapsucking <input type="checkbox"/> - 53 Borer <input type="checkbox"/> - 54 Other</div><div style="width: 25%;"><input type="checkbox"/> - 60 Root <input type="checkbox"/> - 61 Foliage <input type="checkbox"/> - 62 Decays <input type="checkbox"/> - 63 Canker <input type="checkbox"/> - 64 Other</div><div style="width: 25%;"><input type="checkbox"/> - 70 Blowdown <input type="checkbox"/> - 71 Thinning <input type="checkbox"/> - 72 Logging <input type="checkbox"/> - 73 Drought <input type="checkbox"/> - 74 Flood</div><div style="width: 25%;"><input type="checkbox"/> - 75 Hail <input type="checkbox"/> - 76 Snow <input type="checkbox"/> - 77 Frost <input type="checkbox"/> - 78 Wind <input type="checkbox"/> - 79 Fire</div><div style="width: 25%;"><input type="checkbox"/> - 80 Herbicide <input type="checkbox"/> - 81 Air Pollution <input type="checkbox"/> - 82 Salt <input type="checkbox"/> - 83 Animal <input type="checkbox"/> - 84 Bird</div></div>					
Indicate casual agent(s) if known: _____					
19. REMARKS (Enter any pertinent information to indicate severity of damage or symptoms to help identify casual agent. Use Table 1 on instruction sheet above as an aid in describing symptoms.)					
PART B TO BE COMPLETED BY RECEIVING AGENCY					
1. IDENTIFICATION OF CASUAL AGENT (Reply by Entomologist/Pathologist)					
2. INFORMATION REPORTED (X Appropriate Box) <input type="checkbox"/> Reared/Cultured <input type="checkbox"/> Sample Damaged - Resubmit <input type="checkbox"/> Sent out for identification					
3. REMARKS					
4. REPORTED BY (Signature)		5. DATE		6. REPORT NUMBER	

Figure 1.—Forest Insect and Disease Report Form

SUMMARY OF MAJOR DAMAGE TYPES

Insect or Disease	Common Host Species	Symptoms and Signs
No damage	All species	None - healthy trees
Hardwood borers	All hardwoods	The initial symptom is a dark sap spot on the bark surface (often mixed with frass). Eventually, coarse boring particles appear in bark cracks and crevices beneath the point of attack. Old damage appears as knobby overgrowths or scars on the bark surface.
Bark beetles	All pines	Appearance of creamy to yellow and pinkish globs of resin on bark surface which resemble popped corn. If the infestation is well established and some trees still retain their foliage, tunnels or egg galleries are evident on the inner bark surface and on the surface of the sapwood. Streaks caused by blue stain fungi are often also evident on sapwood. Foliage gradually yellows, then reddens.
Terminal, shoot and stem borers	All species	Fresh attacks will show boring dust and frass at the entrance holes located most often at the base of leaf petioles and buds. White to pinkish globs of resin may appear at point of attack. Older attacks are seen as terminal and/or branch die-back due to larval tunnels within the terminal and/or branch. Shoots will show yellow, then red and finally brown needle color.
Other insects (except hardwood borers, shoot borers and bark beetles)	All species	All damage caused by insects not identified in separate categories. Includes hardwood defoliators (e.g., variable oak leaf caterpillars and forest tent caterpillars) and pine defoliators (e.g., redheaded pine sawfly and pine weevils).
Other diseases	All species	All damage caused by disease not identified in separate categories, e.g., red heart of pine, brown spot and leaf diseases. Trees showing disease-caused degrade not identified elsewhere should be coded here.

Insect or Disease	Common Host Species	Symptoms and Signs
Fusiform and canandra rusts	Slash, loblolly, pitch, pond and shortleaf pines	<p>These rusts typically cause the formation of spindle-shaped galls on the stem or branches; many older galls appear as cankers with sunken rotten centers encircled by a callus ridge. Witches brooming is common at galls. The fungus fruits in the spring producing bright orange spores.</p> <p>For reporting purposes, consider all stem cankers, but only those branch cankers occurring within 12 inches (30.5 cm) of the bole.</p>
Root rots	All species	<p>Look for groups of dead or windthrown trees; trees with tufted, thin crowns, which may be yellowing. Conks (fruiting bodies) of various fungi may be present on or near base of diseased trees. Disease is more frequent in trees of reduced vigor, thinned stands, and in trees with butt or root injury. Bark beetles often follow.</p>
Littleleaf disease	Shortleaf and loblolly pines; shortleaf is more susceptible	<p>Affected trees occur in groups. Typically seen are yellow needles, reduced shoot growth and large crops of undersized cones. This disease usually occurs where heavy soils having poor internal drainage dominate the site.</p>
White pine blister rust	Eastern white pine	<p>This disease appears on bole or branch as spindle-shaped swellings bordered by a yellowish discoloration of the bark. Branches and tops flag as the fungus girdles the living tissue. In the Southeast this disease usually occurs above 3,000 feet (914.4 m) elevation.</p>
Hardwood cankers	All hardwoods	<p>Affected trees have dead sunken areas on the stem, frequently with annual callus ridges around the dead areas.</p>
Branch stubs	All species	<p>Branch holes or stubs greater than 4 inches (10 cm) in diameter on the stem (tree 5 inches (12.7 cm) d.b.h. and larger). Branch holes or stubs greater than 1 inch in diameter on stem (trees 1 to 4.9 inches (2.5 to 12 cm) d.b.h.).</p>

Insect or Disease	Common Host Species	Symptoms and Signs
Basal defects	All species	Butt swelling, burls, frost seams, and low branch stubs below d.b.h. are symptoms of basal defect. Conks of decay fungi are often associated with defect.
Pitch canker	Virginia, slash, shortleaf, longleaf, loblolly, eastern white pine, Scotch, Table Mountain and pitch pines (primarily slash, loblolly and shortleaf).	Flagging at ends of branches; pitch flow from affected area; slight swelling on affected stems and twigs; commonly there are crooks in main stems and wilting of current candles. In early stages, there will be a slight depression of the bark.
Fire	All species	Fire scars are usually at base of stem; widespread occurrence in stand. Usually on uphill side on slopes. Signs of charring are generally present on the stem.
Animal	All tree species	Branches clipped off or broken, the bark removed, holes in the stem, tears and tooth marks in the wood are all common symptoms of animal activity.
Beaver	All species	Beavers leave tooth marks and remove bark from the bole of the tree.
Sapsucker	All species	Look for horizontal rows of small holes that may encircle the tree's bole. The bark below the hole is usually streaked or stained by oozing sap.
Weather	All species	Windthrow, ice, frost crack (below d.b.h. use basal defect), broken tops, broken branches, marginal leaf burn, winter burn are the common symptoms.

Insect or Disease	Common Host Species	Symptoms and Signs
Flooding	All species	Yellowing and/or curling downward of leaves, premature leaf-fall, branch and top dieback, tree mortality and high water and silt marks on tree boles are the most common effects of flooding.
Lightning	All species	Lightning causes bark stripping or cracking with damage running from strike point to ground spirally or straight. Tops fading from root damage or top breakage. Bark beetles often invading struck trees.
Suppression and stagnation	All species	Suppressed and stagnated trees are characterized by poor form and small crown. Suppressed trees are overtopped and receive indirect sunlight. Stagnated trees have thin foliage and receive some direct sunlight. Stagnation is usually associated with poor growing sites or overstocked stands.
People	All species	Initials in bark, nails in tree, lantern burn, bark stripped, calloused roots, wire around stem, and ax marks are symptoms of people damage.
Logging & related	All species	Logging scars on stem will have callus ridges within 1 to 2 years after wounding. They are scattered in stands and show no charring. Limb breakage and/or stem scar near crown will occur from the felling of other trees. Look for skid trails, stumps, etc.
Turpentining	Longleaf, slash, and loblolly pines	Damage is seen as exposed wood with V-shaped cuts and heavy pitch flow.
Form (damaging)	All species	All trees with form damage which results in total tree cull or loss of sawtimber value.
Dieback	All hardwoods	Tips of the branches die back. Just a few branches are affected at first with whole branches dying in advanced stages. Tree mortality may result. Dieback is frequently associated with stress caused by unfavorable environment.

HARDWOOD BORERS

Insect borers attacking living hardwood trees cause wood defects which result in millions of dollars of loss in lumber degrade each year. Besides direct damage to the tree from tunnels and associated stains, the borer attacks serve as entry points for decay fungi.

Species affected.—Most hardwood species are attacked by at least one species of wood borers. In the Southeastern United States, oaks are the most heavily damaged species.

Symptoms.—The first indication of borer attack is a dark sap spot on the bark surface resulting from the insect's initial tunneling activity in the tree. Eventually, coarse boring particles are deposited in bark cracks and crevices beneath the attack point. Old damage appears as knobby overgrowths or scars on the bark. Many old attacks appear as small vertical scars on the bark surface. Tunnels inside the wood cannot be seen without removing the bark and cutting into the wood.



Borer attack with bark bleaching caused by sap fermentation.



Sapsoaked areas around borer entrance holes.



Borer attack with bacterial slime.



Scar caused by healing of borer attack.



Two-year-old scar from a wood-boring worm.



Borer attack in black locust.

BARK BEETLES

Bark beetles (*Dendroctonus frontalis*, *Ips avulsus*, *Ips calligraphus*, *Ips grandicollis*, and *Dendroctonus terebrans*) are responsible for more timber mortality among the southern pines than any other group of insects. All sizes of pine may be attacked, and outbreaks may occur which include many acres of affected host trees.

Species affected.—All pines are affected.

Symptoms.—Trees that have been recently attacked usually have red or fading crowns. There normally are white or reddish pitch tubes on the bole of the tree. When the bark is pulled away from the tree, the inside surface of the bark will be etched with feed-

ing and breeding galleries—either winding S-shaped galleries of the southern pine beetle or vertical Y- or H-shaped galleries as in the case of Ips beetles. Attacks are usually associated with some other tree or stand disturbance, such as lightning strikes, annosus root rot or logging activity.

Damage.—Vigorous trees may be able to withstand beetle attack, but during epidemics of the southern pine beetle, all trees in expanding spots are usually killed rapidly. Ips and black turpentine beetles are frequently found in association with these outbreaks and may kill the host. Population trends are difficult to predict.



Aerial view of a bark beetle infestation.



Pines killed by bark beetles.



Pitch tube formed at bark beetle attack point.



Bark beetle galleries on wood after bark has been removed.



Adult bark beetles in wood. (Enlarged 24 times).

TERMINAL, SHOOT, AND STEM BORERS

Terminal, shoot, and stem borers are usually a problem on a localized basis.

Species affected.—All species of pine and hardwood.

Symptoms.—(1) Fresh attacks will show boring dust and frass at entrance holes. (2) Pitch tubes are commonly formed on pine. (3) Yellowing and dying of terminals or shoots appear next. (4) Larval tunnels

(usually in the pitch) can be observed if affected terminals or shoots are cut open.

Damage.—Attacks usually result in terminal and/or branch dieback. Young trees may be stunted, deformed, or killed. Flowering and fruit structures may be killed. Tree aesthetics may be reduced but trees rarely die.



Gall caused by shoot borer attack.



Hole caused by entrance of a shoot borer.



Branch breakage at point of attack by shoot borers.



Dieback and brooming caused by shoot moth attack.

OTHER INSECTS

There are a number of other insects which, because of lesser importance, very sporadic occurrence or difficulty in identifying them, do not permit or justify individual survey status.

Species affected.—All species.

Symptoms.—Hardwood defoliation (often leaving leaf veins intact), conifer defoliation (leaving needles dried, curled or removed), resinosus in pines (which is not

sapsucker or bark beetle caused), flagging of hardwood foliage and insect damage other than that listed in other sections are included here.

Damage.—Damage ranges from almost none to mortality in individual cases. Defoliation usually causes reduced growth. Insect activity in pines which causes resinosus can attract other pests which can compound impact.



Branch mortality caused by insect egg-laying in the branch tissue.



Witches broom caused by an insect.



Hardwood defoliation by insects.



Hardwood defoliation by insects.



Insect activity which causes removal of leaf epidermis.

FUSIFORM AND COMANDRA RUSTS

Fusiform rust is the single most damaging disease of pines in the south. The disease is caused by a fungus, *Cronartium quercum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme*, which requires oaks to complete its life cycle. This disease is most destructive in planted pine stands.

Species affected.—Loblolly, slash, longleaf, pitch and pond pines are most susceptible to infection by the rust fungus. Water, willow, bluejack, blackjack, southern red and turkey oaks are favored alternate hosts.

Symptoms.—This disease is characterized by tapered, spindle-shaped swellings (galls) on the branches or stem of the host

tree. In the spring, when fruiting, these galls appear bright orange. Commonly, old galls on the main stem develop into open-faced cankers.

Damage.—On small stems, death is the usual result of this disease. On bigger stems, where cankers do not girdle the bole, structural weakening is the expected damage. Wind breakage often occurs at the galls. Heavily infested young stands may require replanting or complete regeneration.

NOTE.—Comandra blister rust (caused by *Cronartium comandrae* Pk. Symptoms are indistinguishable in the field from those of fusiform rust. Range maps will be used to prepare the resource reports.



Fusiform canker on the main stem of a pine.



Resinous fusiform canker.



Lethal fusiform stem canker developed from branch canker.



Stand damaged by fusiform rust.

ROOT ROTS

Root rots are caused by various species of fungi, most of which produce conks or mushrooms on or near affected trees.

Species affected.—All species of pines and hardwoods are susceptible to root rots.

Symptoms.—Affected trees frequently occur in groups which usually contain dead or windthrown trees. Diseased trees have crowns that can be thin, tufted, yellowing, or browning. If a color change is evident, it will be noticed first at the outer edges of the crown, and be either uniformly

distributed, or progressing from top down. Fruiting bodies may be found on the tree butts, in litter, or on roots of infected trees. Root rots are more frequent in trees of reduced vigor, and in thinned stands; bark beetles often attack trees with root rots.

Damage.—Reduced tree growth and mortality of pole size and larger trees are the results of root rots. Root rots also predispose trees to attack by other pests (e.g., bark beetles).



Windthrown tree resulting from root disease.



Resin soaking at base of tree caused by root disease (bark removed).



Fruiting bodies of a root rot fungus.



Crown symptoms of tree affected by root disease.



External resin flow on a root-diseased tree.



Stand breakup caused by root rot.

LITTLELEAF

Littleleaf disease is a severe problem on pines in the Southeast. Caused by a complex, including the fungus *Phytophthora cinnamomi* Rands., nematodes, poor soil fertility and a variety of species of *Phythium*, this disease causes severe local problems.

Species affected.—Shortleaf is the most severely affected species of pine. Loblolly pine is affected to a lesser degree.

Symptoms.—The symptoms of this disease normally appear only in older trees (20+) when competition for root space

begins. The prime symptom is a thin, off-color (yellow-green) crown. Subsequently, the crown will appear stagheaded as branch systems die back. An extremely heavy cone crop (distress crop) is produced during the growing season 1-2 years preceeding death of the tree.

Damage.—Tree death is the normal outcome of this disease. Usually within 7 to 10 years of first symptom expression the tree will be dead.



Shortleaf pine affected by littleleaf.



Typical littleleaf spot showing declining and dead trees.



Typical thin crowned trees affected by littleleaf disease.



Distress crop of abnormally small cones produced 1-2 years prior to death of tree.

WHITE PINE BLISTER RUST

Blister rust, caused by the fungus *Cronartium ribicola* Fisch., is a canker disease that causes branch, top, and tree mortality of the five-needled pines. It is an introduced disease that requires an alternate host to complete the infection cycle.

Species Affected.—The white pines (five-needled) are attacked and damaged while the alternate hosts, members of the genus *Ribes* (currant, gooseberry, etc.) experience little damage.

Symptoms.—Two years after infection, spindle shaped swellings (cankers) bordered by yellowish discoloration form on the branch or stem adjacent to the infection point. These cankers elongate and girdle the branch by killing the underlying tissue. Yel-

low spores are formed on the cankers in the fall with white spores forming the following spring in the same place. Infected branches turn red (flag), which is the most recognizable symptom in the field. Cankers can grow into the main stem and cause top killing.

Damage.—The most common damage to pole size and smaller trees is top-killing and branch mortality. Larger trees may contain flagged branches or tops, but are not killed. Blister rust is site dependent, being most severe where the microclimate is favorable for distribution and germination of the spores from the *Ribes*. Such sites in the Southeast are found on the north aspect and above 3,000 feet (914.4 m) in elevation.



Typical spring appearance of a white pine blister rust canker.



Fruiting branch canker caused by white pine blister rust fungus.



Fruiting main stem canker caused by white pine blister rust fungus.

HARDWOOD CANKERS

Hardwood cankers (caused by a variety of fungi) seriously reduce the quantity and quality of forest products by deforming the main stem. Damage generally is localized in certain stands and age class. Cankers are normally associated with an injury (mechanical, environmental, insect, etc.), which is required for the fungus to enter the tree.

Species affected.—All hardwoods; with black walnut, birch, beech, aspen, oak, and maple being more commonly affected.

Symptoms.—Cankers are localized

lesions in the bark and outer wood. They may be roughened, discolored, or sunken, and frequently show annual callus ridges (target cankers). Damage may be only in the sapwood or may extend into the heartwood. Cankers are most noticeable when they are on the trunk or major branches.

Damage.—Cankered trees are normally degraded or even culled. They are weakened at the canker point and are easily broken by wind and ice.



Fruiting body of the fungus causing a main stem canker.



Perennial canker on the hardwood.



Cankers on the main stems of hardwoods.

BASAL DEFECTS

Basal defects are deformities or injuries that occur on the lower 4½ feet (137 cm) of the trunk. They lower the value of the tree. Decay frequently occurs in trees having basal defects. The defect is the entry point for decay-causing organisms.

Species affected.—All species of trees are damaged.

Symptoms.—Butt swellings (burls), elongated frost cracks, and low branch stubs

are symptomatic of this category of basal defects. Conks of decay fungi may also be found on affected trees.

Damage.—Basal defects are more likely to be found in disturbed stands such as those that have been high graded or grazed. Loss is dependent on the extent of injury and decay. Butt logs are often rendered worthless.



Decay column in the single remaining stem of a V-crotch tree resulting from decay of the cut stem.



Fungal fruiting body associated with a basal defect.



Burls on the butt log of a tree.

BRANCH STUBS

Branch stubs provide an entry point for decay organisms. The larger the branch stub the greater the chance for decay.

Species affected.—All species are affected, but hardwoods seem to have more damage of this type.

Symptoms.—Old branch stubs which have not completely callused over may be invaded by disease organisms. Also look for holes where a branch had been in the main

stem. These holes or stubs must be greater than 4 inches in diameter (trees 5 inches (12.7 cm) d.b.h. and larger) or greater than 1 inch (2.5 cm) in diameter (trees 1 to 4.9 inches (2.5 to 12 cm) d.b.h.) to be significant.

Damage.—Branch stubs or holes provide entry points for decay organisms. Degrade to complete cull can result from the decay. In many cases the stem will break because of structural weakening.



Branch stub.



Portion of stem (longitudinal section) showing decay column originating at branch stub.

PITCH CANKER OF PINES

Pitch canker (caused by *Fusarium moniliforme* var. *subglutinans* (Wr.) Reink.) causes substantial deformity, growth loss and mortality in planted pines in the South. The most severely affected slash pine plantations are in Florida, but the disease is becoming a serious problem in several pine species in seed orchards throughout the South.

Species affected.—Pitch canker damages Virginia, south Florida slash, slash, shortleaf, longleaf, and loblolly pines. Other hosts include eastern white, Scotch, Table-Mountain, pitch, sand and Monterey pines.

Symptoms.—Cankers form on the bole, branches, and shoots of affected trees. Cankers on shoots result in dieback characterized by flagging and thinning of the

crown. Needles on recently killed shoots are yellow to reddish brown, later turning greenish brown to dark grey. Shoot cankers are usually annual, while cankers on the bole and larger branches are perennial. Cankers protrude from the bark surface and contain copious amounts of resin. The underlying wood is pitch soaked, often to the pith.

Damage.—In plantations, pole size trees with extensive shoot dieback may die, while lesser affected trees suffer reduced growth. Normally, younger trees are not killed but are deformed. In seed orchards, trees with bole cankers are usually killed. The quantity and quality of the seed may be reduced.



Early stage of pitch canker damage.



Terminal shoot damage.



Flagging of terminals and lateral shoots caused by the pitch canker fungus.



Pitch-soaked canker.

OTHER DISEASES

There are a number of less important diseases which do not deserve individual survey status, but as a group could cause substantial loss. Most of these are caused by fungi and result in leaf spots, defoliation or stem deformities.

Species affected.—All species are affected. Conifers will commonly have needle spots and limb distortion. Hardwoods will have leaf spots and distortion of the main stem and branches. Both groups will have heartrot which is not coded elsewhere.

Symptoms.—Needle spots, defoliation, main stem distortion, branch swelling, heartrot (such as red heart in pine), mottling and curling of foliage, necrotic foliage, witches brooms, mistletoe, and a variety of damage types that are not treated under another code.

Damage.—The damage varies from almost none to mortality in individual cases. Foliage problems normally cause reduced growth, while stem damage may result in tree breakage, decay, degrade or death.



Witches broom caused by a fungus.



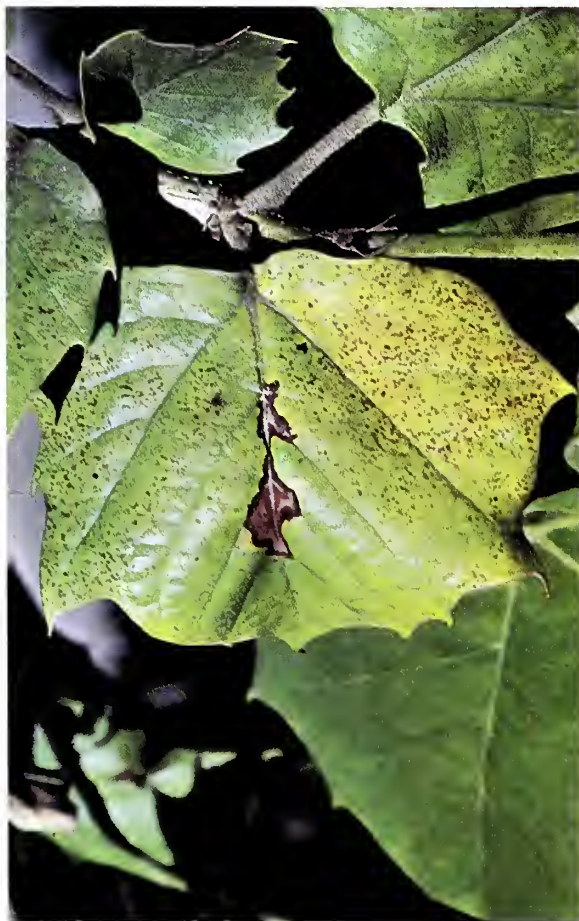
Severe leaf blotch caused by a fungus.



Pine needles with fruiting stage of a needle rust.



Tree parasitized by many true mistletoe plants.



Leaf blotch on sycamore.



Needle spots caused by a fungus.

FIRE

Fire is a primary cause of basal wounding which can serve as the entry point for disease and decay causing organisms. Butt rot often develops in trees that have been damaged by fire. Insects, such as beetles and wood borers, are attracted to trees stressed by fire damage.

Species affected.—Although some species of trees are fire-tolerant, all species of pine and hardwood may be damaged or killed by fire, particularly during the seedling/sapling stages.

Symptoms.—Fire scars usually occur at the base of the tree and normally on the up-

hill side where there is a slope. Charred areas are normally present on the bark of affected trees. In a stand, high incidence of butt rot, old trunk scars and hollow boles can be evidence of a past fire, especially if several different tree species are affected.

Damage.—Damage is more apparent on younger trees, with the bark dropping off, exposing wood where fungi can enter. Fire causes severe damage or death of plant tissue. Decay causing organisms often enter through fire wounds. Damage resulting from fire is often compounded by a preexisting disease, e.g., fusiform rust.



Fire line to prevent spread of forest fire.



Burning following a logging operation.



Butt rot following fire damage of hardwoods.

ANIMAL DAMAGE

Birds, rodents, deer, bear, and rabbits can cause substantial damage to trees. (Beavers are covered separately.) The damage may take the form of feeding, nesting, rubbing or uprooting a complete tree.

Species affected.—All species are affected. Each animal species seems to show a preference for certain species or height of tree. Woodpeckers seek out decayed or insect-infested trees, rodents look for thin-barked trees, deer for trees having easily reached branches, rabbits for young tender growth, etc.

Symptoms.—Branches clipped off, bark removed, branches broken, holes in the stem, tear marks in the bark, etc., are commonly caused by animals. In most cases teeth marks, claw marks, peck marks or a type of physical tearing are associated with the damage.

Damage.—Deformity is the most common type of damage. In many cases, the wounds provide entry points for decay organisms, and attract insects. In rare cases, the trees may be stressed and die.



Tree killed by rodent feeding.



Evidence of feeding by rodent on bark.

BEAVER

In many areas of the South, beaver populations have become large enough to become a nuisance or even a serious problem in forest stands near streams and other water habitats.

Species affected.—Beavers prefer willows, sweetgums, cottonwood, poplar, birch, and maple. However, they will feed on alder and pine.

Symptoms.—Large areas of bark may be removed to expose the cambial layer which is used for food. The trunks of sawtimber-sized trees may be completely girdled. Small trees may be deeply gnawed or

even completely felled. The damage appears as if someone took an ax and cut the tree down by repeated chipping completely around the hole. Large teeth marks can be observed on damaged surfaces. Beaver ponds, lodges, and dams might be seen in the vicinity.

Damage.—Trees may be killed directly by girdling or felling. Dams cause flooding which may result in tree damage and mortality. Trees stressed by feeding wounds or flooding are more susceptible to disease and insect attacks.



Tree trunks gnawed by beavers.

SAPSUCKER DAMAGE

Sapsuckers are birds which get their name from the habit of boring small holes into the cambial layer or inner bark, letting the sap exude and run down the trunk. They then wipe up or suck the oozing sap with their brush-like tongue, returning again and again to the same tree. They also consume the insects attracted to the exudate.

Species affected.—All tree species, both conifers and hardwoods, are susceptible to sapsucker attack.

Symptoms.—Holes are less than 0.4 inch (1 cm) in diameter and are arranged in horizontal rows. Some rows may encircle the tree's bole. The bark is often stained or streaked from resin and gum flow.

Damage.—Sapsucker holes eventually heal and create blemishes in the wood grain, lowering its market value. These holes also serve as infection courts for disease-causing organisms.



Sapsucker holes and resulting sap flow.

WEATHER

Significant annual timber loss results directly from adverse weather. Temperature, wind, water, and lightning damage, and often kill, forest trees (flooding and lightning are covered later).

Species affected.—All species are affected.

Symptoms.—Broken or shattered branches or stems, windthrown trees, defoliation caused by heat, drought or frost, winter burn, broken bark resulting from hail impact, frost cracks, sunscald of bole or branches and marginal leaf burn are associated with adverse weather.

Damage.—Callus formation (and subsequent degrade) commonly occurs at wounds. Multiple leader trees often result when the terminal is lost. Death is a common outcome for weather damaged trees. Also, the open wounds caused by weather are ideal for subsequent attack by decay fungi.



Limbs broken by ice and wind.



Storm-damaged trees.



Storm-damaged trees.



Ice-damaged trees.



Winter-injured trees (cold temperature).

FLOODING

The effects of flooding vary a great deal depending on the species and age of the affected trees, the characteristics of the soil, and the depth and duration of flooding. While flooding can be beneficial to tree growth, it is more often detrimental.

Species affected.—All species of pine and hardwood are susceptible to damage from flooding. While some species (e.g., green ash, sycamore, cottonwood, willow, sweetgum, and baldcypress) are called flood

resistant, even they are damaged by flooding which is too deep or prolonged.

Symptoms.—Flood-damaged trees may show yellowing or downward curling of leaves, or even premature leaf-fall. Branch dieback may be noticeable. Look for high water and silt marks on the tree trunks.

Damage.—Tree growth may be reduced. Branch and tree mortality may result. Increased susceptibility to insect and disease organisms commonly occurs. Flooding often kills trees.



Flooding caused by dam construction.



Flooding.



Trees killed by flooding.

LIGHTNING

Lightning-struck trees vary in extent of injury and are often found on ridge tops in hilly country. Struck trees can attract pests such as the southern pine beetle, which then multiply and spread.

Species affected.—All species are affected.

Symptoms.—Although quite variable, some form of bark damage will usually be evident from the point of strike to the ground. Bark can be completely stripped,

slightly cracked, or unaffected. Damage can follow a spiral or straight pattern to the ground, and top breakage may occur.

Damage.—Single trees or groups of trees may be affected, dying quickly or slowly, depending on the voltage and temperature of the bolt. Outbreaks of the southern pine beetle can result when lightning struck trees provide breeding places for the beetles.



Lightning-struck tree.

SUPPRESSION AND STAGNATION

Suppressed trees are trees in uniform stands with respect to both species and age class; they are entirely below the general level of the crown cover, and receive no direct light from above or the sides. These trees are likely to become stagnated, i.e., grow slowly, have poor form and sparse foliage. Stagnation is also the normal result of restricting growth by overstocking or underthinning a stand. Open grown trees may also become stagnant because of poor soil, low vigor, etc.

Species affected.—All species are vul-

nerable to these problems.

Symptoms.—Understory or overtopped trees which are suppressed or stagnated will show virtually no growth and will commonly be poorly formed. “Dog hair” stands with too many, too thin trees are generally stagnated.

Damage.—Volume loss from stagnation and suppression occur in poorly managed stand or stands on unsuitable sites. Stagnated and suppressed trees are readily attacked by insects and diseases which result in spot or stand kill.



Stagnant pine stand.

PEOPLE

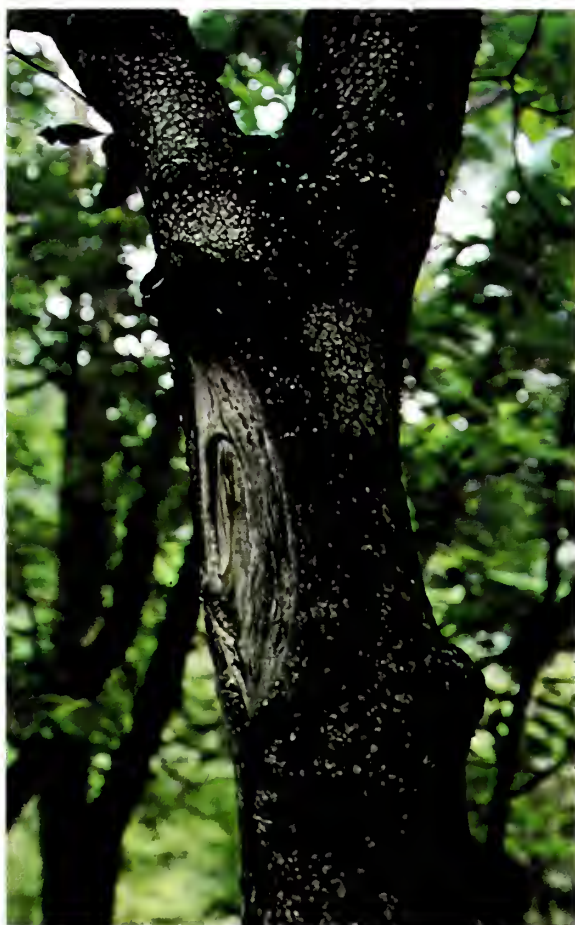
People-caused damage is most common in recreational or urban areas. Trees in recreational areas almost invariably show obvious damage caused by unthinking or careless users of the forest resource.

Species affected.—All tree species are affected.

Symptoms.—Basal wounds or cankers, initials carved in trees, bared roots (commonly with the upper side bark worn off and callus ridges), bark patches knocked off or burned off and bark ridges encircling tree

(often with wire still showing), are obvious symptoms of man's activity. Later typical decline symptoms will be expressed; crown thin, leaves off color, stagheaded, etc.

Damage.—Normally, except in heavy use areas, the damage is mechanical and results in the formation of a callus overgrowth which degrades the value of the tree. In high use areas where soil compaction is routine, decline due to root injury usually results in death.



Scar caused by lantern burn.



Initials carved in bark.



Roots exposed by traffic and erosion.



Calloused wounds.



Bolt imbedded in tree.

LOGGING

Often during a logging operation, all trees in a stand are not removed. There may be plans to harvest residual trees at a later date. If so, care should be taken to minimize damage to the remaining trees. In many cases, residual trees (especially hardwoods) are so damaged that within a few years, they are of no merchantable value.

Species affected.—All species can be damaged by logging activities.

Symptoms.—Trees can be knocked over and main stems broken during logging procedures. Bark can be knocked off, deep wounds can be made by machinery and

falling trees, and branches may be broken. Look for skid trails, stumps, exposed roots, etc. One to 2 years after logging, callus ridges form around the wounds.

Damage.—Some trees are killed. Many are wounded so that butt rot and canker formation eventually takes place. Tree form can be ruined. Untreated stumps and damaged roots may serve as entry points for root disease causing organisms.

This results in significant degrade to the residual stand. Insect pests are attracted to the damaged trees. Sometimes populations build up in the damaged trees and spread to surrounding healthy stands.



Damage from logging machinery.



Fruiting bodies of a decay fungus on a logging wound.

TURPENTINING

Turpentine is the practice of wounding trees to stimulate the production of naval stores (resin). Trees that are turpented will be found in designated areas, with all trees wounded in a similar manner.

Species affected.—Slash, longleaf, and loblolly pines are the primary affected species.

Symptoms.—V-shaped scars in exposed wood will be evident on trees that have been turpented. Heavy pitch flow

from scars can also be found.

Damage.—No economic damage is caused by turpentine as the trees are intentionally grown for that purpose. Tops can be salvaged for pulpwood and various products, and stumps are bulldozed up and processed for their pitch content. Where turpentine borers successfully attack these trees, the additional weakening at the point of attack may permit wind breakage.



Fresh turpentine scars on a pine.



Turpentine face with collection cup.



Turpentine face with collection cup.

FORM DAMAGING

Millions of dollars are lost annually as a result of degrade in deformed trees. In many cases, the cause for the damage is unknown and may have occurred many years before, but is still present as a damage to the form of the tree.

Species affected.—All species are affected, especially hardwoods planted outside of their natural range.

Symptoms.—Any type of damage

which results in a crooked or multi-branched stem and subsequently causes degrade to the affected tree.

Damage.—The trees are almost never killed. They are crooked, multibranched, growing at an angle or deformed to such a degree that the value of the tree is reduced. Many times this deformity will degrade a tree from veneer to lumber or from lumber to cordwood or even to cull.



Pine deformed by an unidentified agent.

DIEBACK

A variety of causes may result in the general decline in vigor of affected trees. The same basic pattern of dieback may be expressed by different hosts suffering from different problems. Generally, if the causal agent is known, the problem is renamed and removed from this broad category.

Species affected.—All species are affected although hardwoods are more commonly reported than are softwood species.

Symptoms.—Premature leaf fall, off color, thin residual crown and stag-headed appearance of crown are the most common symptoms of a dieback problem. Epicormic branching often occurs on hardwoods.

Damage.—In some cases, trees apparently recover when lateral branches fill in where obvious damage has occurred. However, very often the tree simply continues to decline over several seasons until it finally dies.



Decline and dieback.



Dieback and sparse foliage.



Thin crown and top dieback in hardwoods.



Branches dying back in top.

